Limits of the applicability of the geometrical optics in the radio occultation techniques derived from the numerical simulations of the parabolic diffraction equation.

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Results of the numerical simulations of the radio occultation experiment are presented. The ground based radiating antenna, oriented towards the planet under investigation, forms the illuminated spot about one million kilometers in diameter. The signals are coherently received and analyzed on board the spacecraft. Such experimental setup significantly increases the energetic potential of the link Earth-satellite and ensures high spatial and temporal resolution achieved in the experiment.

Dekameter waves are suited for the investigation of the fine structures of the planetary ionosphere, because they ensure strong ionospheric variations of the signal due to propagation through inhomogeneous plasma, and small instrumental fluctuations due to instabilities of the local oscillator onboard the spacecraft.

However, too strong distortions of these signals prevent application of the ray optics methods to the data analysis and interpretation. In the present work, the amplitudes and phases of the signals along the Venus orbiter trajectory have been simulated numerically within the parabolic diffraction equation approximation [1]. The model has been validated with the results of radio occultation data obtained from the VENERA-15 and VENERA-16 experiments. Linear relation of the frequency deviation with the intensity of the radiation propagated through the inhomogeneous ionosphere, is proved. The simulation results revealed the criteria, allowing to determine the limits of applicability of the geometrical optics. One of these criteria is the breakdown of the linear relation of the frequency variation with the radiation intensity.

The primary attention in the investigation is paid to the analysis of the role of the diffraction effects due to small scale plasma structures, which are present in the ionosphere.

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